GEOTECHNICAL INVESTIGATION FOR PERFORMING SLOPE STABILITY ANALYSIS
PROPOSED DEVELOPMENT
51 TANNERY STREET
MISSISSAUGA, ONTARIO

Prepared for:

OHE CONSULTANTS

PATRIOT ENGINEERING LTD.
Consulting Engineers

Project 37105
March 24, 2017

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Toronto, Ontario
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PATRIOT
ENGINEERING LTD.
Consulting Engineers

Project 37105

March 24, 2017

OHE Consultants
311 Matheson Boulevard East
Mississauga, Ontario
L4Z 1X8

Attention: Mr. Mike Grayhurst, P.Eng.

Geotechnical Investigation For
Performing Slope Stability Analysis
Proposed Development
51 Tannery Street
Mississauga, Ontario

1.0 INTRODUCTION

On behalf of OHE Consultants, Patriot Engineering Ltd. has carried out a geotechnical investigation at the above site to determine the soil and groundwater conditions. The purpose of our investigation was to perform slope stability analysis in order to provide geotechnical comments on the long term stability of the existing slope for the construction of the proposed development. Authorization to proceed with this investigation was provided by Mr. Mike Grayhurst, of OHE Environmental Inc., on behalf of the owners.

At this time, the location footprint and size of the proposed buildings on the site is not known. In this regard, the proposed development has not been determined yet. Recently, we had also carried out a separate *Preliminary Geotechnical Investigation* our *Report No. 37105, dated February 1, 2017*, and provided preliminary comments for the proposed development, such as, type of foundations, safe soil bearing pressures, excavation and backfilling procedures, plus slab-on-grade construction. In this regard, this report should be read in conjunction with the above mentioned *Preliminary Geotechnical Investigation Report No. 37105, dated February 1, 2017*.

The site is located approximately 1000m south and 500m west from the intersection of Queen Street South and Britannia Road West, in Mississauga, Ontario. The majority of the terrain is relatively flat, except for the northeast quadrant which is situated approximately 1.0m higher in elevation. An existing downward slope is also present along the western region of the property, which is the focus of our investigation.

We had measured the slope contours at four sections of the subject slope along the west face of the property. The slope heights and slope angles show slight variations at each section. From a general perspective, at the four subject sections, the existing slope heights were approximately 3.7m, 3.7m, 4.6m and 4.8m, respectively, and the average angles of the existing slope, β, were measured to be approximately 39, 33, 30 and 29 degrees, respectively.

The upper tablelands leading to the crest of the slope are generally covered with grass and are sufficiently vegetated. Currently, the slope face contains a sufficient amount of mature trees and is adequately covered with vegetation. The toe of the slope is generally dry and is also covered with vegetation. The flat lands beyond the toe are also vegetated and lead to Mullet Creek, which is in close proximity to the slope. Photographs of the slope are shown in the attached Appendix A.

At the time of our visit, there was no evidence of surface erosion/gullies, nor any tension cracks nor any evidence of features that would be of concern regarding the slope and its stability.

2.0 FIELDWORK

The fieldwork for this investigation took place on March 1, 2017, and consisted of drilling a total of four (4) boreholes (BH201 to BH204) to depths ranging from 7.7m to 9.2m, using solid stem augers.

We have also surveyed the borehole locations and four (4) existing slope profiles, using tape and level methods. The approximate borehole locations along with their surface elevations at the time of our drilling activity are shown on the Site Plan, Figure 1.

The ground surface elevations for the boreholes and slope profiles were determined by members of our field engineering staff and referenced at:

> City of Mississauga bench mark at Station No. 00819638004. It is located on the north face of the foundation wall of the limehouse brick building at Tannery Road and Queen Street South. The tablet is set horizontally 490mm east of the northwest corner and 50mm below the brick work.

The elevation at this point is understood to be at Elev. 163.423m

The scope of work for the geotechnical investigation for this project is as it is presented in this report, which is being provided on the assumption that the applicable codes and standards will be met. If there are any changes in the design features relevant to the geotechnical analysis, or if there are any apparent deviations of the report from relevant codes and standards, our office should be contacted to review the design.

3.0 SUBSURFACE CONDITIONS

The detailed stratigraphy encountered in the boreholes is presented on the borehole logs, Drawings 2 to 5 inclusive.

In general, all boreholes with the exception of Borehole 202, were drilled from above a granular fill covered area and initially advanced through a 50mm thick layer of compact, brown, moist to very moist, crusher run limestone. While Borehole 202 was drilled from above a concrete paved region and initially advancing through the existing concrete, which was approximately 100mm in thickness. Below the concrete, loose, brown, moist, crusher run limestone was present. Its thickness was 100mm.

Beneath the above mentioned cover layers, earth fill materials were present in all boreholes. In Boreholes 202 and 204, the earth fill material was composed of loose to compact, brown, moist to very moist, sandy silt fill. This material also contained some clay, along with traces of gravel, cobbles, topsoil, rootlets and asphalt fragments. The moisture contents ranged from 12% to 17%. Below the sandy silt fill layer, a second fill layer was present in the same Boreholes 202 and 204 and consisted of firm to very stiff, brown and/or reddish brown, and/or dark brown, and/or grey, slightly moist to very moist, clayey silt fill. This fill material was also present in Boreholes 201 and 203, below the surficial granular cover materials. It also contained some sand, plus traces of gravel, cobbles, topsoil, rootlets, asphalt fragments, brick fragments and wood pieces. The moisture contents varied from 11% to 27%. Grain size distribution test results from a sample that was obtained from this clayey silt fill material is shown on Figure 6. The depth of the fill layers inside the boreholes extended to depths that varied from 4.0m to 4.9m below existing grade. The topsoil/organics that were detected within the fill layers, appeared to be infrequent, isolated and of insignificant concentrations.

Underlying the fill layers, native, compact to very dense, grey, and/or brown, moist to slightly moist, sandy silt till layer was encountered in all boreholes. Some clay, plus traces gravel, cobbles and shale fragments, as well as, isolated wet sand seams were also observed within this material. Minor dilation was noted in some of the soil samples extracted from this layer. The moisture contents that were recorded within this layer fell between 4% and 20%. Figure 7, shows the grain size distribution test results that was performed on a sample obtained from this sandy silt till material.

Below the overburden soil, all boreholes then encountered shale bedrock and were terminated in it. These boreholes penetrated the shale bedrock to depths ranging from approximately 0.6m to 2.8m. The shale was weathered and grey in colour. Based on the geology of the area, the shale is of the Georgian Bay formation, which is usually grey and mainly weathered on the upper strata.

At the borehole locations, the top surface of the shale bedrock varied slightly and was generally situated between Elev. 150.1m and Elev. 150.4m. Based on the site topography at the time of our investigation, this translated to approximate depths of 6.4m to 7.0m below the existing grade surface.

The short term groundwater levels that were recorded inside the boreholes upon completion of drilling are indicated below in Table 1. These groundwater level readings are also shown on the individual borehole logs.

Table 1
Measured Short Term Groundwater Levels Upon Completion of Drilling

Borehole No.	Depth of Borehole (m)	Borehole Surface Elevation (m)	Approximate Depth of Groundwater Level Below Existing Ground (m)	Approximate Groundwater Elevation (m)
201	9.2	156.6	4.3	152.3
202	7.7	156.8	4.1	152.7
203	7.7	156.9	4.9	152.0
204	7.7	157.1	5.5	151.6

Long term groundwater levels have not been established and some seasonal fluctuations and higher water levels should be anticipated.

The soil and groundwater conditions presented in this report have been deducted from soil sampling that was noncontinuous and therefore, should not be taken to represent exact planes of geological change. Furthermore, the geotechnical recommendations and comments provided in this report have been based on boreholes that were widely spaced. Therefore, the soil and groundwater conditions between the boreholes could vary significantly.

The amount of boreholes required to determine the localized underground conditions between boreholes that would affect construction costs, sequencing, equipment, scheduling construction techniques, and the like, would be much greater than that which was carried out for design purposes. Contractors and/or subcontractors bidding on or undertaking the work should, in this light, decide on their own interpretations of the factual borehole results, so that they may draw their own conclusions as to how the subsurface conditions may affect them and their scope of work.

4.0 SLOPE STABILITY ANALYSIS

A slope stability analysis was performed for the existing slope along the west face of the property. This analysis was carried out to establish whether the existing slope meets the criteria for long term stability. Our analysis was performed on four sections that were obtained in this area, Sections AA, BB, CC and DD, as shown on the Site Plan, Figure 1.

4.1 Slope Geometry

The fieldwork for this part of the investigation involved individually surveying Sections AA to DD, to determine their existing ground surface contours and also advancing Boreholes 201 to 204 to depths ranging from 7.7m to 9.2m, to establish the soil stratigraphy at these four sections. Borehole 201 was used for Section AA. Borehole 202 was used for Section BB. Borehole 203 was used for Section CC. While Borehole 204 was used for Section DD. With this information, we then produced the cross-sectional profiles of:

Section AA, which is shown on Figure 1A
Section BB, which is shown on Figure 1B
Section CC, which is shown on Figure 1C
Section DD, which is shown on Figure 1D

Our reconnaissance indicated that the average angle of the existing slope, β, at each section is approximately as follows:

Section AA, β = 39 degrees
Section BB, β = 33 degrees
Section CC, β = 30 degrees
Section DD, β = 29 degrees

4.2 Erosion Rates

A review of the slope was made to determine the setback distances to be applied to the predicted stable slope crest based on the predicted erosion over a 100 year period.

As previously mentioned, the slope is in close proximity to Mullet Creek. Based on site measurements it is noted that at all four sections, the distance from the toe of the slope to the edge of Mullet Creek is less than 15m. The Credit Valley Conservation guidelines state that if the above mentioned distance is less than 15m, then to use a 4m setback distance for the 100 year erosion component. We have applied this setback distance to our analysis at the four sections.

4.3 Development Setback

As a general guideline, it is recommended that in order to maintain a stable slope, development should not take place within 10m of a stabilized slope crest. The proposed structures at this site are expected to be located outside of this 10m zone, and therefore, we have applied this setback distance to our analysis at the four sections.

4.4 Computerized Slope Stability Analysis

Since various failure mechanisms may occur, a common mode of failure that was reviewed for this slope involved the possibility of rotational failure. This method is based on engineering modelling and computerized stability analysis to determine the long term stable slope. This analysis was carried out on the same Sections AA to DD, shown on the Site Plan, Figure 1.

For a rotational failure type mode, the failure plane may be assumed to be on a curved surface which may be approximated by a circular arc. Therefore, a method using the Simplified Bishop Method of Slices with effective stresses was used for our analysis.

The soil stratigraphy that was obtained from each borehole which was drilled for each corresponding profile section is shown on Figures 1A to 1D, respectively. In the absence of detailed direct shear and triaxial strength tests to establish cohesion and internal angles of friction, the soil parameters were estimated, as shown on the above mentioned Figures 1A to 1D.

4.4.1 Safety Factor Requirements

The possibility of slope movement is evaluated by comparing the forces resisting failure to those causing failure. This ratio is the factor of safety. At limiting equilibrium, the resisting and the driving forces are equal, and the factor of safety is 1.0. A factor of safety of less than 1.0 represents an undesirable failure condition.

A factor of safety which is commonly used for engineering design to assess the stability of slopes is 1.5m, for developments located close to the slope crest. Most common design guidelines are based on this criteria of using a 1.5 as a minimum factor of safety for active land use.

Therefore, a long term factor of safety of 1.5 or greater is recommended for this site.

4.4.2 Method Of Analysis

A computerized circular failure analysis based on the Simplified Bishops Method applied the assumed soil and groundwater conditions to complete an effective stress analysis and calculate factors for safety for various circles.

The factor of safety is affected by variations in strength of the layered soils and seasonal fluctuations in the groundwater levels, and therefore the computed factor of safety will vary for different soil sections, and dry and wet seasons.

4.4.3 Discussions And Recommendations

The results of the Simplified Bishops Method of analysis are shown on Figures 1A to 1D. As previously mentioned, a minimum factor of safety of 1.5 is recommended for long term stability. It is our opinion that the stabilized crest of the slope occurs where a failure circle with a minimum factor of safety of 1.5 intercepts the ground surface at the upper tableland.

At Section AA (Figure 1A), Section BB (Figure 1B) and Section DD (Figure 1D)

The stabilized crest of the slope with a failure circle that has a minimum factor of safety of 1.5 which intercepts the ground surface at the upper tableland is indicted on our Section AA, Section BB and Section DD. From the existing crest of the slope, it is located inward by a distance of 1.2m, 0.4m and 0.8m, for Section AA, Section BB and Section DD, respectively. A standard precaution is to add a minimum 4m toe erosion component setback distance plus a 10m development setback distance, for a combined total of 14m, behind this stabilized crest of slope which is represented with the imaginary circle that has a factor of safety of 1.5. We referred this as the "Development Line". Development of the structures can then take place inward of the Development Line at the area that we designated as the "Zone of Development". This is illustrated in Figures 1A, 1B and 1D.

At Section CC (Figure 1C)

For the above Section CC, our analysis assisted us to identify the location of the most critical circle which recorded the lowest available factor of safety, which was 1.8. From the existing crest of the slope, it is located inward by a distance of 0.4m. Considering that this was the lowest attainable value, it still exceeds the minimum criteria of 1.5. Again at these section, a standard precaution is to add a minimum 4m erosion component setback distance plus a 10m development setback distance for a combined total of 14m, behind this stabilized crest of slope. Typically, this 14m distance should be added inward from the point where the imaginary circle with a factor of safety of 1.5 meets the ground surface. However, we have used a conservative approach and added a 14m setback distance from the imaginary circles with factors of safety of 1.8, and this new point is identified as the Development Line. As indicated above, development of the structures can take place within the area described as Zone of Development, which is inward of the Development Line, as illustrated in Figure 1C.

A summary of the results of our slope stability analyses indicating the safety factors and setback distances relative to the existing crest of the slope at each of the four section is shown below on Table 2.

Table 2
Summary of Results of Slope Stability Analysis

Profile Section	Figure No.	Factor of Safety (F.S.)	Distance from Existing Crest of Slope to Stabilized Crest of Slope (m)	Toe Erosion Setback Distance (m)	Development Setback Distance (m)	Total Combined Setback Distance Relative to Existing Crest of Slope (m)
AA	1A	1.5	1.2	4	10	15.2
BB	1B	1.5	0.4	4	10	14.4
CC	1C	1.8	0.4	4	10	14.4
DD	1D	1.5	0.8	4	10	14.8

In conclusion, the proposed structures are expected to be located behind the imaginary circles with an estimated factor of safety of 1.5 in Sections AA, BB and DD, plus 1.8 in Section CC, along with a 14m setback distance added inward to each of these sections. Based on the soil and groundwater conditions encountered in the boreholes and our analysis of the stability of the slope, it is our opinion that the existing slope is stable with respect to long term stability and we do not expect a deep seated failure to occur. Therefore the proposed structures are at low risk of slope failure. However, we do expect minor localized erosion to occur at the slope face, if surface water runoff is not adequately controlled and if the slope is not sufficiently vegetated. Also, the building loads will have minimal and insignificant effects on the long term stability of the slope, as they will be transferred and dissipated onto native, competent soils with adequate bearing capacities using a deep foundation system consisting of caissons or helical piers.

4.5 Precautionary Comments

Some slope creep and loss of ground due to localized erosion and sloughing of the slope faces may occur, however, this can be controlled by the owner with regular inspections and maintenance, as needed. The following precautionary measures should be complied with in order to maintain slope stability:

(a) No temporary or permanent surcharge loads, or fills should be placed near the slope crest. Overstressing of the soil can cause sudden failure damaging surrounding land and structures.

(b) Further measures should be taken to protect against surface erosion by installing interceptor drains at the top of the slope to prevent surface water runoff and prevent perched groundwater levels. Seepage and groundwater pressures should be decreased by drainage systems and surface water should be controlled to decrease infiltration to potential side areas.

(c) Surface drainage from the structure or any paved surface should not be permitted to discharge over the slope. Such surface discharge should be directed away from the flow of the slope.

(d) Vegetation should be promoted as a further measure to reduce surface erosion. Grass, deep rooted vegetation and mature trees should be planted and maintained.

(e) No heavy and or vibratory equipment should be used near the slope crest.

(f) Water pipe outlets and the like should not discharge over the slope crest.

(g) Any nearby erosion gullies should be stabilized, if and when they develop.

(h) In the event that remedial work may be required in the future, grout injections may be performed to strengthen the soil and fill cavities in the soil, provided that the soil permeability is satisfactory. Such work should be carried out under the direction of a consultant.

(I) During the construction period, a sediment fence must be installed at the rear of the lot to alleviate the transport of sediment down the slope.

(j) The toe of the slope must be protected from erosion and undercutting.

It is important to note that there are above normal risks associated with buildings constructed near slopes versus flat ground, and therefore some future slope creep, cracking and maintenance must be anticipated by the owners. The information contained within this report should be applied to its intended purpose in accordance with the relevant building codes and municipal regulations.

Considering the above recommendations, we feel that from a geotechnical viewpoint, it is feasible to construct the proposed structures at the area designated as the Zone of Development in Figures 1A to 1D, provided that all geotechnical recommendations and the current Ontario Building Code requirements are followed.

We trust this report will assist you with your proposed development. Should you have any questions, please do not hesitate to contact our office.

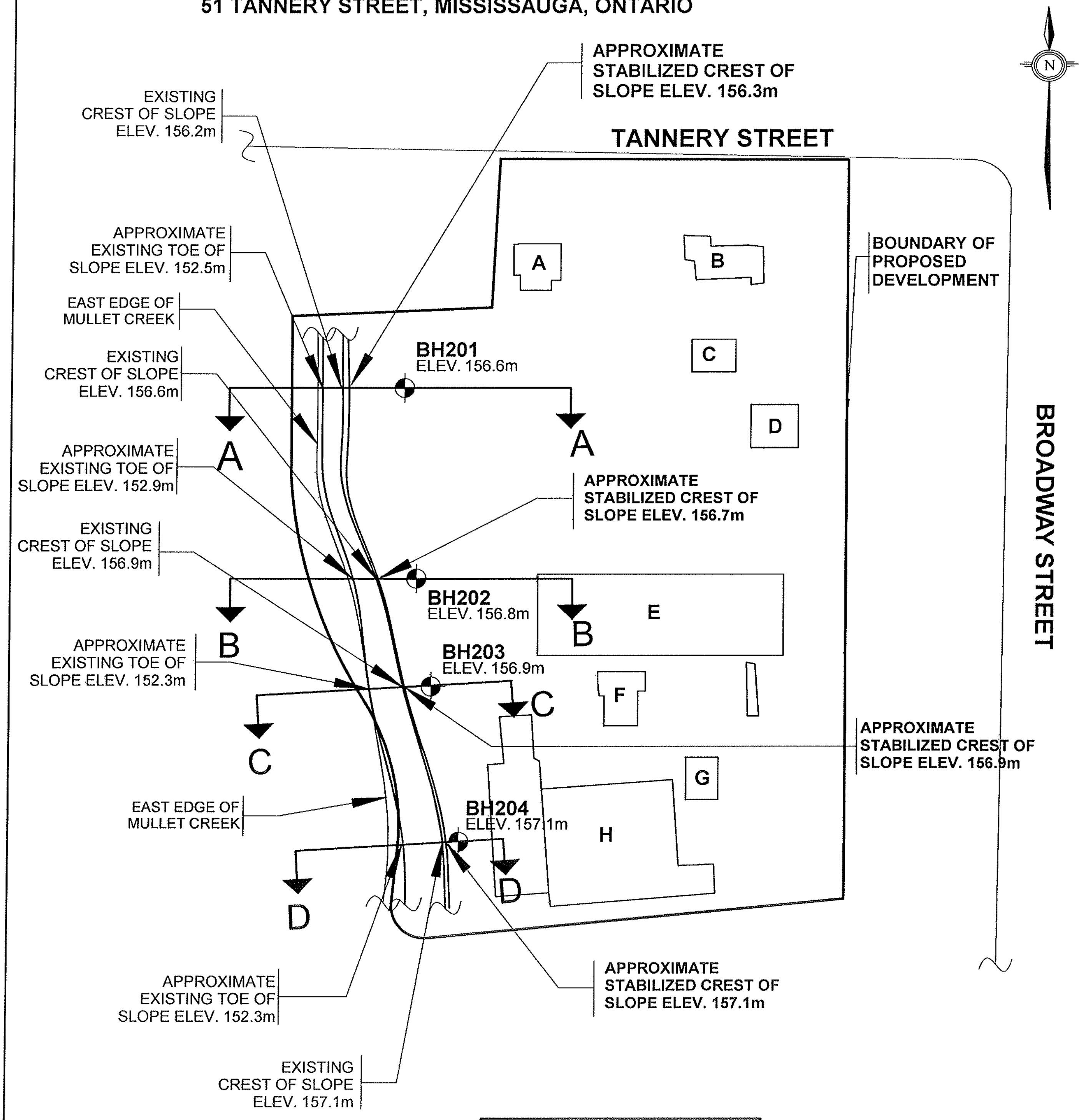
Sincerely,
PATRIOT ENGINEERING LTD.

Larry Galimanis, P.Eng.
Principal/Consulting Engineer

LICENSED PROFESSIONAL ENGINEER
L. GALIMANIS
PROVINCE OF ONTARIO

Distribution: Mr. Mike Grayhurst, OHE Consultants (4)

FIGURE 1: SITE PLAN SHOWING THE APPROXIMATE BOREHOLE LOCATIONS
PROPOSED DEVELOPMENT
51 TANNERY STREET, MISSISSAUGA, ONTARIO



REFERENCE:

SITE PLAN INFORMATION ADAPTED FROM PROPOSED BOREHOLE/MONITORING WELL LOCATIONS DRAWING NO. A4, PREPARED BY OHE CONSULTANTS DATED DECEMBER 2016.

NOTE:

BUILDINGS A TO H ARE EXISTING STRUCTURES INTENDED TO BE DEMOLISHED TO ALLOW FOR THE PROPOSED DEVELOPMENT

LEGEND

⊕ BOREHOLE

Drawn By	Name	Date
	S.B.	Mar' 17
Checked By	L.G.	Mar' 17
Revisions		
Scale	1:1500	

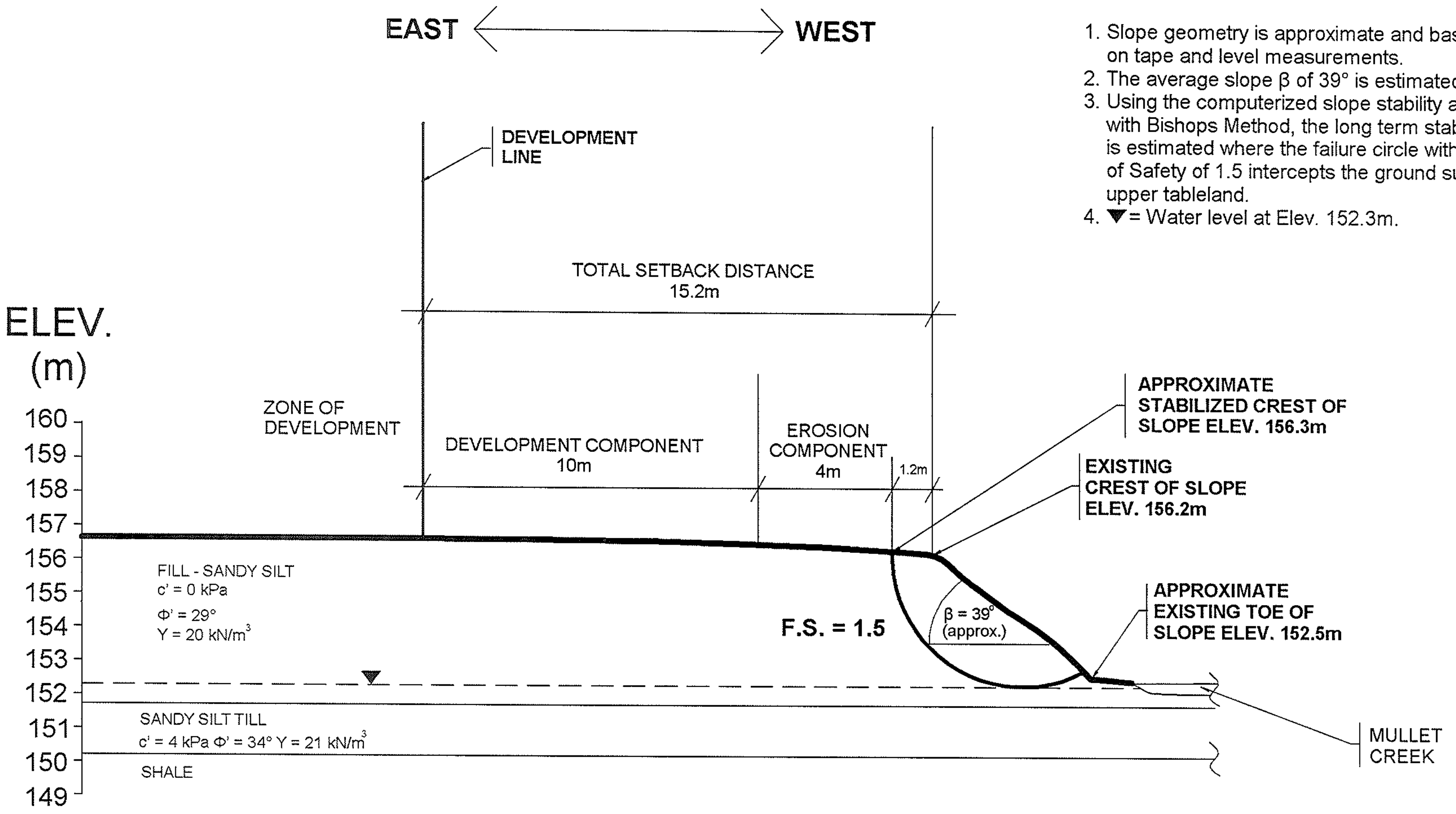
PATRIOT ENGINEERING LTD.
Consulting Engineers

Project: 37105

Figure: 1

Notes:

1. Slope geometry is approximate and based on tape and level measurements.
2. The average slope β of 39° is estimated.
3. Using the computerized slope stability analysis with Bishops Method, the long term stable slope is estimated where the failure circle with a factor of Safety of 1.5 intercepts the ground surface at upper tableland.
4. ▼= Water level at Elev. 152.3m.



SECTION AA SCALE 1:200

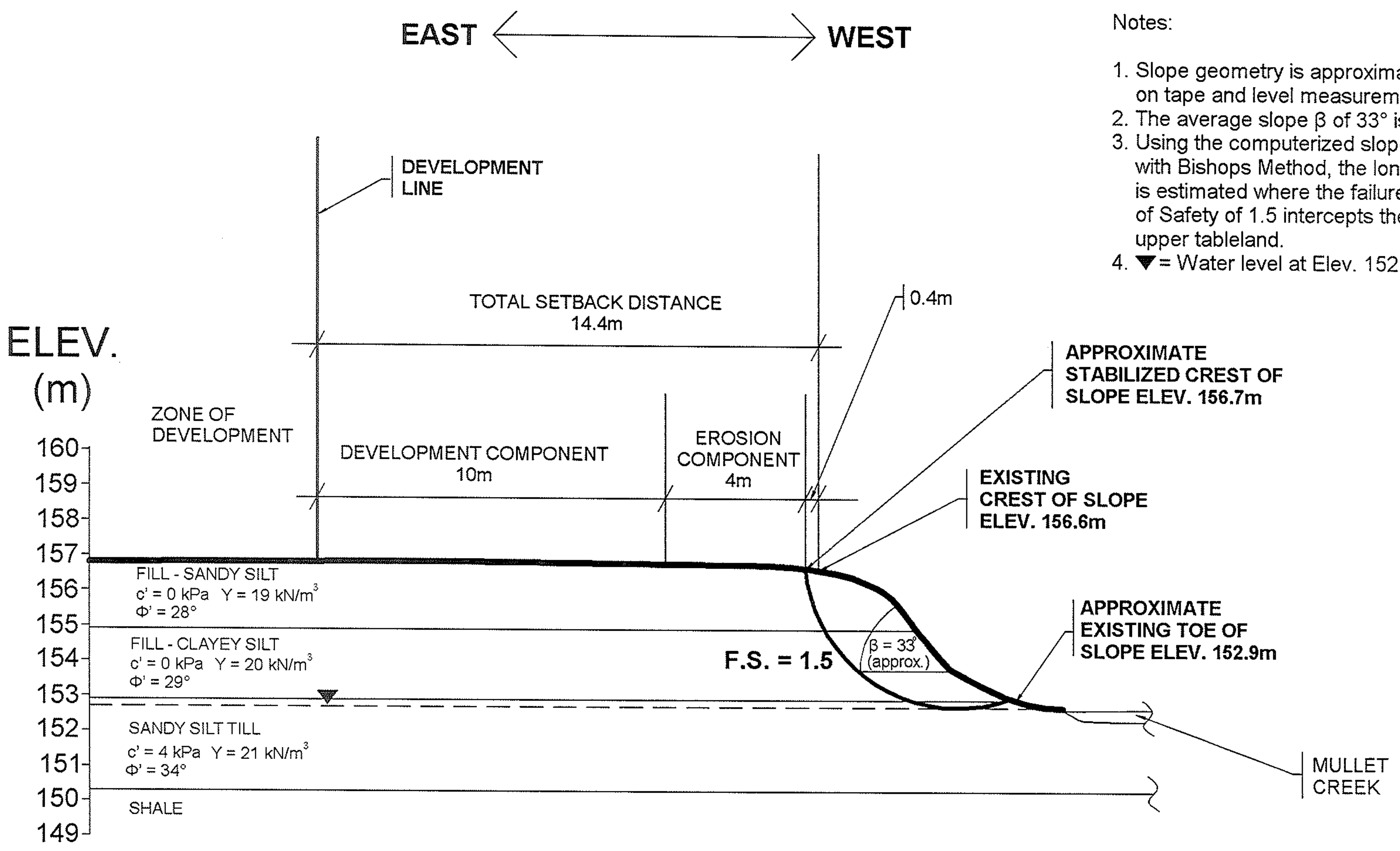
SOIL STRATIGRAPHY OBTAINED FROM BOREHOLE BH201
LATERAL EXTENT AND DEPTH OF STRATIGRAPHY VARIES

	Name	Date
Drawn By	S.B.	Mar '17
Checked By	L.G.	Mar '17
Revisions		
Scale	1:200	

PATRIOT ENGINEERING LTD.
Consulting Engineers

Project: 37105

Figure: 1A



Notes:

1. Slope geometry is approximate and based on tape and level measurements.
2. The average slope β of 33° is estimated.
3. Using the computerized slope stability analysis with Bishops Method, the long term stable slope is estimated where the failure circle with a factor of Safety of 1.5 intercepts the ground surface at upper tableland.
4. ▼ = Water level at Elev. 152.7m.

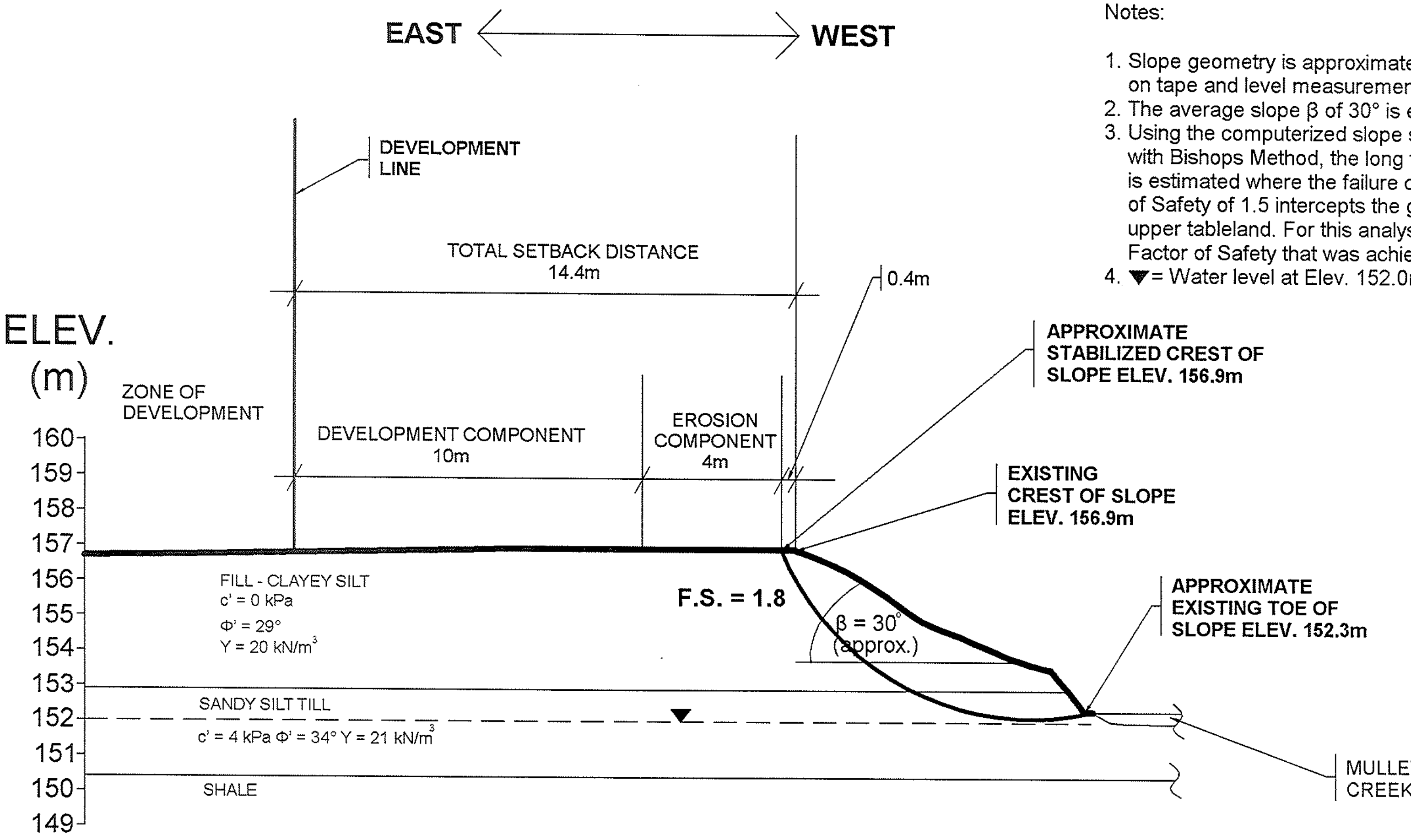
SECTION BB SCALE 1:200

SOIL STRATIGRAPHY OBTAINED FROM BOREHOLE BH202
LATERAL EXTENT AND DEPTH OF STRATIGRAPHY VARIES

	Name	Date
Drawn By	S.B.	Mar '17
Checked By	L.G.	Mar '17
Revisions		
Scale	1:200	

PATRIOT ENGINEERING LTD.
Consulting Engineers

Project: 37105
Figure: 1B



Notes:

1. Slope geometry is approximate and based on tape and level measurements.
2. The average slope β of 30° is estimated.
3. Using the computerized slope stability analysis with Bishops Method, the long term stable slope is estimated where the failure circle with a factor of Safety of 1.5 intercepts the ground surface at upper tableland. For this analysis, the minimum Factor of Safety that was achieved was 1.8.
4. ▼= Water level at Elev. 152.0m.

SECTION CC SCALE 1:200

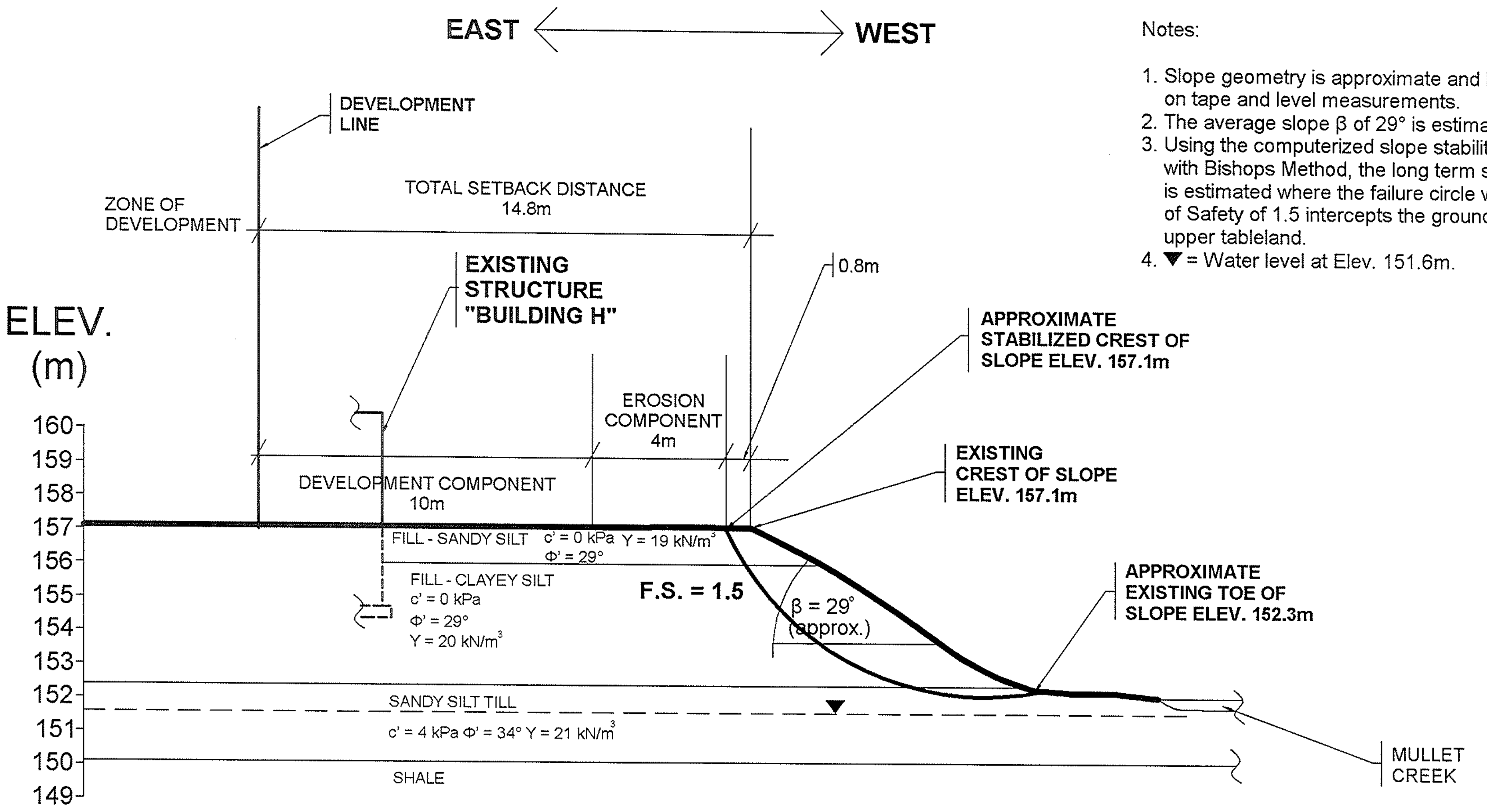
SOIL STRATIGRAPHY OBTAINED FROM BOREHOLE BH203
LATERAL EXTENT AND DEPTH OF STRATIGRAPHY VARIES

	Name	Date
Drawn By	S.B.	Mar '17
Checked By	L.G.	Mar '17
Revisions		
Scale	1:200	

PATRIOT ENGINEERING LTD.
Consulting Engineers

Project: 37105

Figure: 1C



Notes:

1. Slope geometry is approximate and based on tape and level measurements.
2. The average slope β of 29° is estimated.
3. Using the computerized slope stability analysis with Bishops Method, the long term stable slope is estimated where the failure circle with a factor of Safety of 1.5 intercepts the ground surface at upper tableland.
4. ▼ = Water level at Elev. 151.6m.

SECTION DD SCALE 1:200

SOIL STRATIGRAPHY OBTAINED FROM BOREHOLE BH204
LATERAL EXTENT AND DEPTH OF STRATIGRAPHY VARIES

	Name	Date
Drawn By	S.B.	Mar '17
Checked By	L.G.	Mar '17
Revisions		
Scale	1:200	

PATRIOT ENGINEERING LTD.
Consulting Engineers

Project: 37105

Figure: 1D

Project No: 37105

Borehole #: BH201

Project: Proposed Development

Borehole Location: See Figure 1

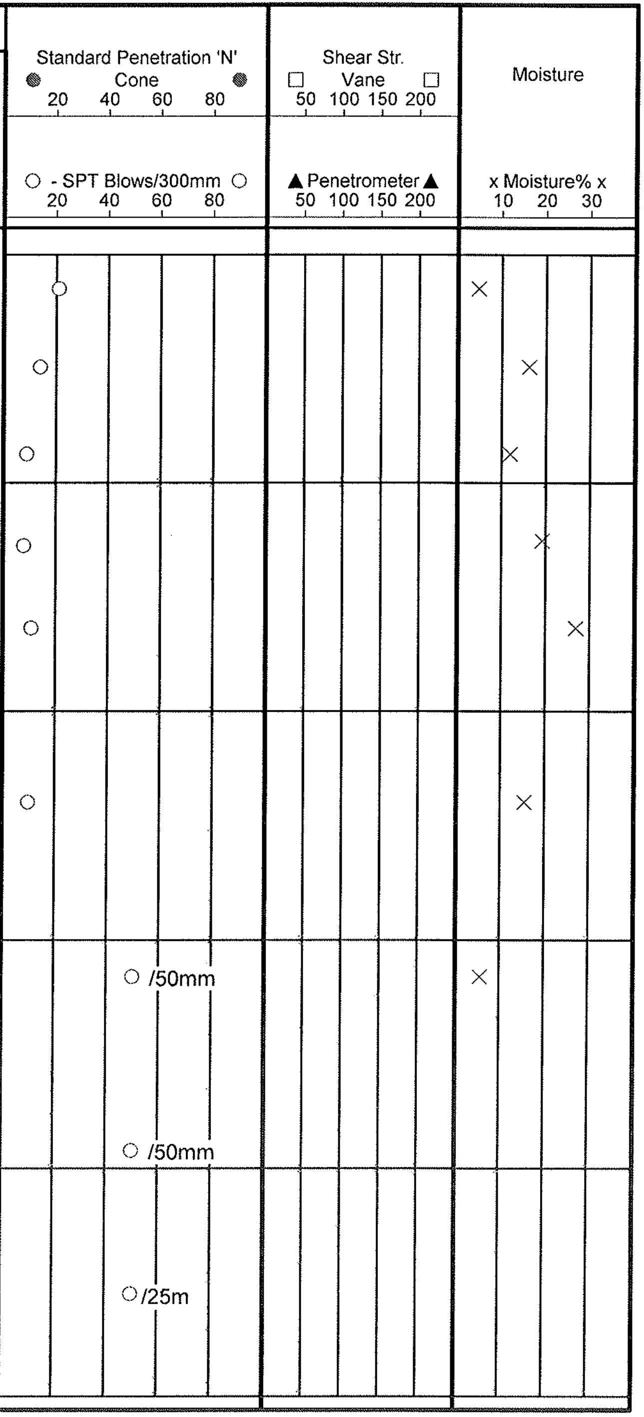
Location: 51 Tannery Street, Mississauga, Ontario

Project Engineer: L.G.

Client: OHE Consultants

Drawing No.: 2

SUBSURFACE PROFILE				SAMPLE			
Depth (m)	Symbol	Description	Elevation (m)	Type	N = Blows/300mm	Recovery (%)	U.Wt.(kN/m3)
		Ground Surface	156.6				
0		***GRANULAR FILL - 50mm CRUSHER RUN LIMESTONE*** compact, brown, slightly moist		SS1	21	50	
1		***FILL - CLAYEY SILT*** very stiff to stiff, reddish brown becoming grey with depth, slightly moist to very moist, some sand, trace gravel, trace cobbles, trace topsoil, isolated pockets of topsoil, trace asphalt fragments, trace wood pieces		SS2	14	60	
2				SS3	9	65	
3				SS4	8	80	
4				SS5	11	60	
			151.7	SS6	10	80	
5		***SANDY SILT TILL*** compact to very dense, grey, moist to slightly moist, some clay, trace gravel, trace cobbles, trace shale fragments, isolated wet sand seams, oxidized					
6			150.2	SS7	50	100	
7		***SHALE*** weathered, grey, Georgian Bay Formation					
8				SS8	50	100	
9			147.4	SS9	50	100	
10		***GRINDING AUGER REFUSAL*** See notes on next page.					



Drill Method: S/S Auger

Drill Date: March 1, 2017

PATRIOT ENGINEERING LTD.
80 Nashdene Road., Unit 62, Toronto, ON, M1V 5E4
Phone: (416) 293-7716 Fax: (416) 293-6722
e-mail: info@patrioteng.ca

Datum: Geodetic

Checked by: L.G.

Project No: 37105

Borehole #: BH201

Project: Proposed Development

Borehole Location: See Figure 1

Location: 51 Tannery Street, Mississauga, Ontario

Project Engineer: L.G.

Client: OHE Consultants

Drawing No.: 2

SUBSURFACE PROFILE				SAMPLE						
Depth (m)	Symbol	Description	Elevation (m)	Type	N = Blows/300mm	Recovery (%)	U.Wt.(kN/m3)	Standard Penetration 'N' ● Cone ● 20 40 60 80 ○ - SPT Blows/300mm ○ 20 40 60 80	Shear Str. ☐ Vane ☐ 50 100 150 200 ▲ Penetrometer ▲ 50 100 150 200	Moisture x Moisture% x 10 20 30
11 12 13 14 15 16 17 18 19 20		Notes: 1. Borehole was advanced using solid stem augers to a depth of 9.2m on March 1, 2017. 2. Short term groundwater level measured at 4.3m depth upon completion of drilling.								

Drill Method: S/S Auger

Drill Date: March 1, 2017

PATRIOT ENGINEERING LTD.
80 Nashdene Road., Unit 62, Toronto, ON, M1V 5E4
Phone: (416) 293-7716 Fax: (416) 293-6722
e-mail: info@patrioteng.ca

Datum: Geodetic

Checked by: L.G.

Project No: 37105

Borehole #: BH202

Project: Proposed Development

Borehole Location: See Figure 1

Location: 51 Tannery Street, Mississauga, Ontario

Project Engineer: L.G.

Client: OHE Consultants

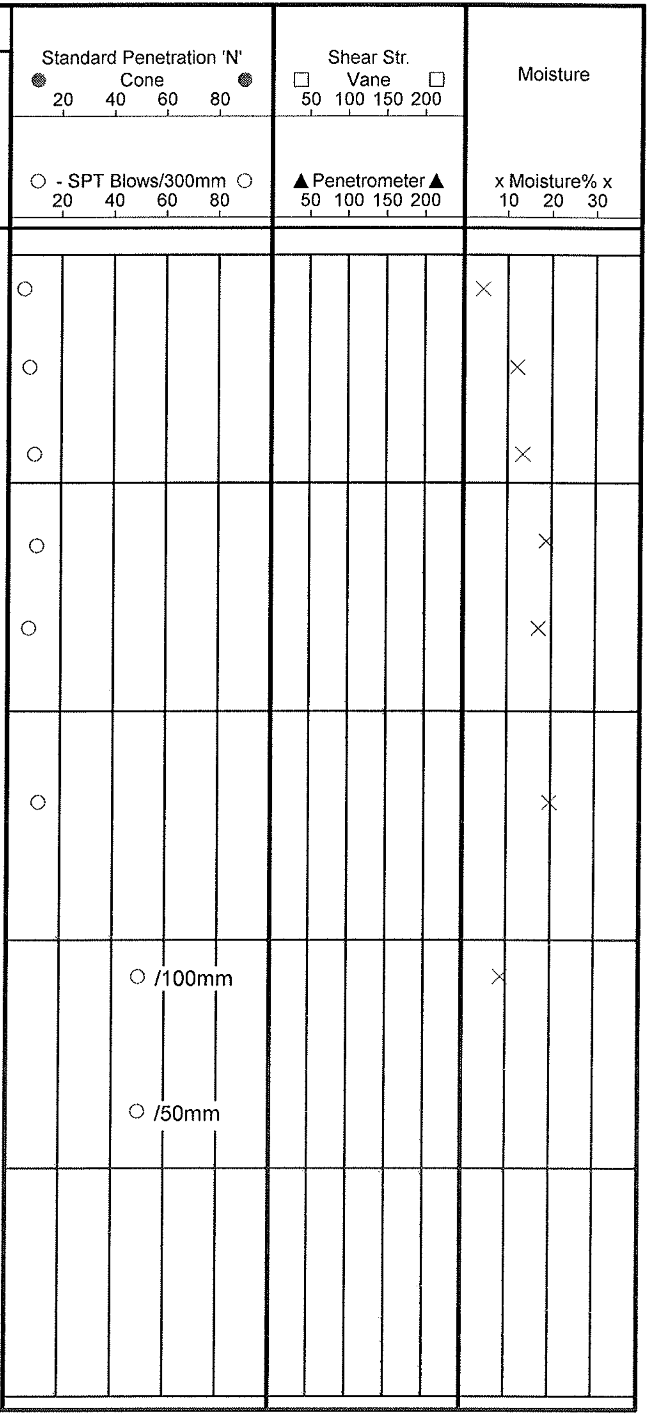
Drawing No.: 3

SUBSURFACE PROFILE		SAMPLE			
Description	Elevation (m)	Type	N = Blows/300mm	Recovery (%)	U.Wt.(kN/m3)
Ground Surface	156.8				
CONCRETE SLAB - 100mm	156.6				
GRANULAR FILL - 100mm CRUSHER RUN LIMESTONE loose, brown, slightly moist		SS1	6	20	
FILL - SANDY SILT loose to compact, brown, slightly moist to moist, some clay, trace gravel, trace topsoil, trace rootlets	154.9	SS2 SS3	8 10	55 55	
FILL - CLAYEY SILT stiff, reddish brown, moist, some sand, trace gravel, trace cobbles, trace asphalt fragments, trace wood pieces, trace rootlets	152.8	SS4 SS5	11 8	80 60	
SANDY SILT TILL compact to very dense, grey, moist to slightly moist, some clay, trace gravel, trace cobbles, trace shale fragments, isolated wet sand seams, oxidized, minor dilation detected in SS6	150.3	SS6 SS7	12 50	85 100	
SHALE weathered, grey, Georgian Bay Formation	149.1	SS8	50	100	
GRINDING AUGER REFUSAL					

Notes:

1. Borehole was advanced using solid stem augers to a depth of 7.7m on March 1, 2017.

2. Short term groundwater level measured at 4.1m depth upon completion of drilling.



Depth (m): 0 1 2 3 4 5 6 7 8 9 10

Drill Method: S/S Auger

Drill Date: March 1, 2017

PATRIOT ENGINEERING LTD.
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e-mail: info@patrioteng.ca

Datum: Geodetic

Checked by: L.G.

Project No: 37105

Borehole #: BH203

Project: Proposed Development

Borehole Location: See Figure 1

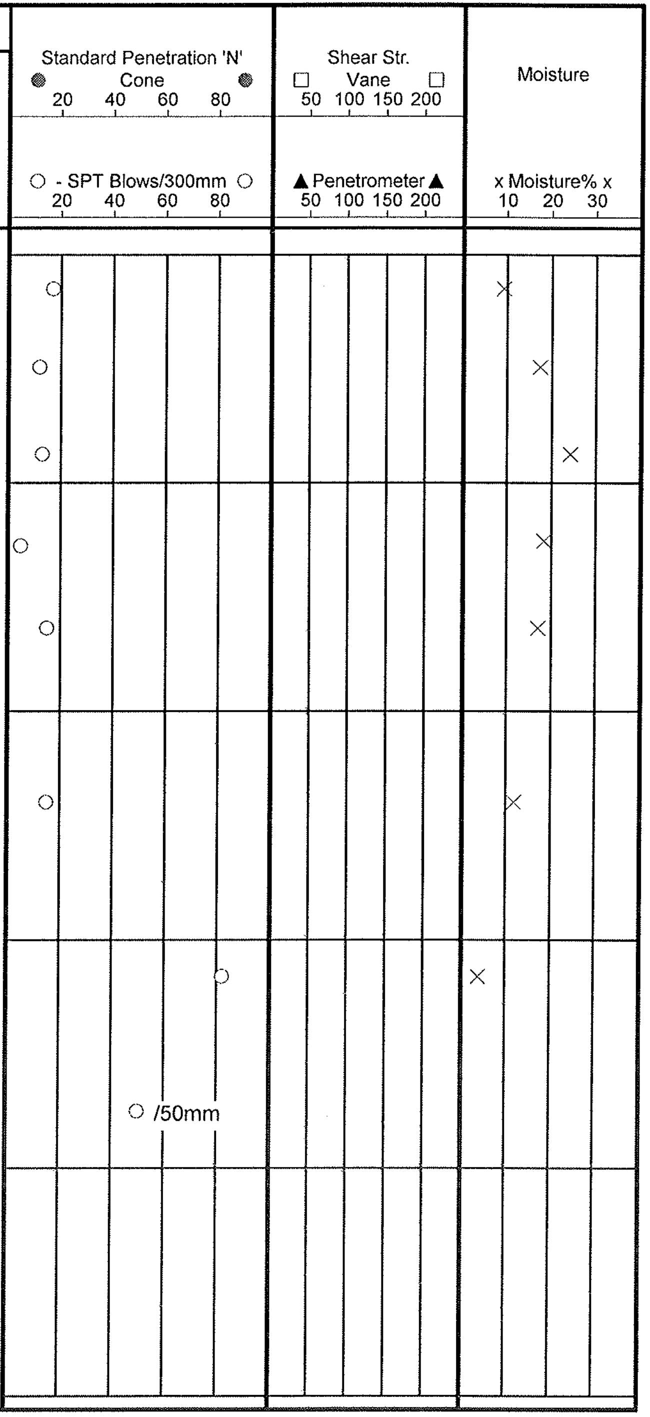
Location: 51 Tannery Street, Mississauga, Ontario

Project Engineer: L.G.

Client: OHE Consultants

Drawing No.: 4

SUBSURFACE PROFILE				SAMPLE			
Depth (m)	Symbol	Description	Elevation (m)	Type	N = Blows/300mm	Recovery (%)	U.Wt.(kN/m3)
		Ground Surface	156.9				
0		***GRANULAR FILL - 50mm CRUSHER RUN LIMESTONE*** compact, brown, slightly moist		SS1	17	75	
1		***FILL - CLAYEY SILT*** very stiff to firm, brown becoming grey with depth, slightly moist to very moist, some sand, trace gravel, trace cobbles, trace topsoil, isolated pockets of topsoil, trace asphalt fragments, trace brick fragments, trace rootlets		SS2	12	80	
2				SS3	13	75	
				SS4	5	80	
3				SS5	15	90	
			152.9				
4		***SANDY SILT TILL*** compact to very dense, grey, moist to slightly moist, some clay, trace gravel, trace cobbles, trace shale fragments, isolated wet sand seams, oxidized, minor dilation detected in SS6					
5				SS6	15	90	
6			150.4	SS7	82	90	
7		***SHALE*** weathered, grey, Georgian Bay Formation	149.3	SS8	50	100	
8		***GRINDING AUGER REFUSAL*** Notes: 1. Borehole was advanced using solid stem augers to a depth of 7.7m on March 1, 2017. 2. Short term groundwater level measured at 4.9m depth upon completion of drilling.					
9							
10							



Drill Method: S/S Auger

Drill Date: March 1, 2017

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Datum: Geodetic

Checked by: L.G.

Project No: 37105

Borehole #: BH204

Project: Proposed Development

Borehole Location: See Figure 1

Location: 51 Tannery Street, Mississauga, Ontario

Project Engineer: L.G.

Client: OHE Consultants

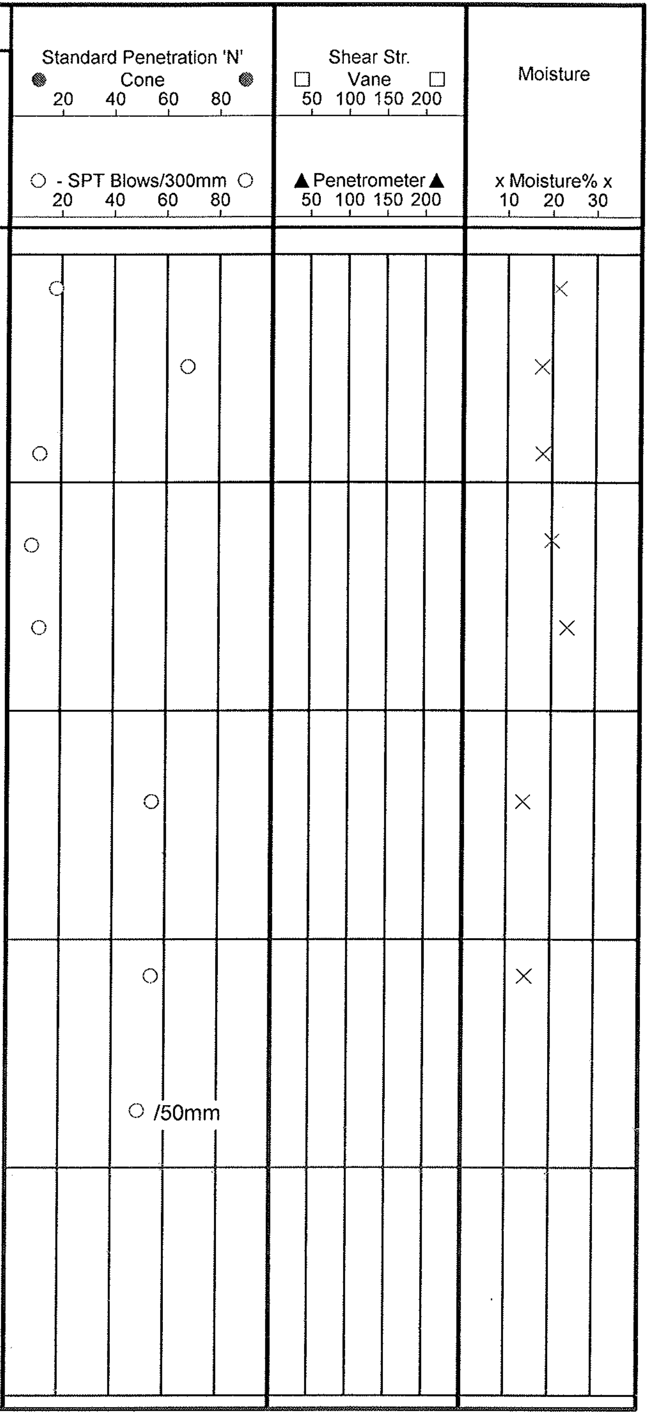
Drawing No.: 5

SUBSURFACE PROFILE

Description	Elevation (m)
Ground Surface	157.1
GRANULAR FILL - 50mm CRUSHER RUN LIMESTONE compact, brown, very moist	
FILL - SANDY SILT compact, brown, very moist to moist, some clay, trace gravel, trace cobbles, trace asphalt fragments	156.0
FILL - CLAYEY SILT very stiff to stiff, brown becoming dark brown with depth, moist to very moist, some sand, trace gravel, trace cobbles	152.4
SANDY SILT TILL very dense, brown, becoming grey below 5.0m depth, moist, some clay, trace gravel, trace cobbles, trace shale fragments, isolated wet sand seams, oxidized, minor dilation detected in SS6	150.1
SHALE weathered, grey, Georgian Bay Formation	149.5
GRINDING AUGER REFUSAL	
See notes on next page.	

SAMPLE

Type	N = Blows/300mm	Recovery (%)	U.Wt.(kN/m3)
SS1	18	75	
SS2	68*	80	
SS3	12	75	
SS4	9	80	
SS5	12	90	
SS6	55	90	
SS7	55	90	
SS8	50	100	



Drill Method: S/S Auger

Drill Date: March 1, 2017

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Checked by: L.G.

Project No: 37105

Borehole #: BH204

Project: Proposed Development

Borehole Location: See Figure 1

Location: 51 Tannery Street, Mississauga, Ontario

Project Engineer: L.G.

Client: OHE Consultants

Drawing No.: 5

SUBSURFACE PROFILE				SAMPLE						
Depth (m)	Symbol	Description	Elevation (m)	Type	N = Blows/300mm	Recovery (%)	U.Wt.(kN/m3)	Standard Penetration 'N' ● Cone ● 20 40 60 80 ○ - SPT Blows/300mm ○ 20 40 60 80	Shear Str. ☐ Vane ☐ 50 100 150 200 ▲ Penetrometer ▲ 50 100 150 200	Moisture x Moisture% x 10 20 30
		Notes: * "N" value (blows/foot) not representative due to a cobble obstruction. 1. Borehole was advanced using solid stem augers to a depth of 7.7m on March 1, 2017. 2. Short term groundwater level measured at 5.5m depth upon completion of drilling.								
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										

Drill Method: S/S Auger

Drill Date: March 1, 2017

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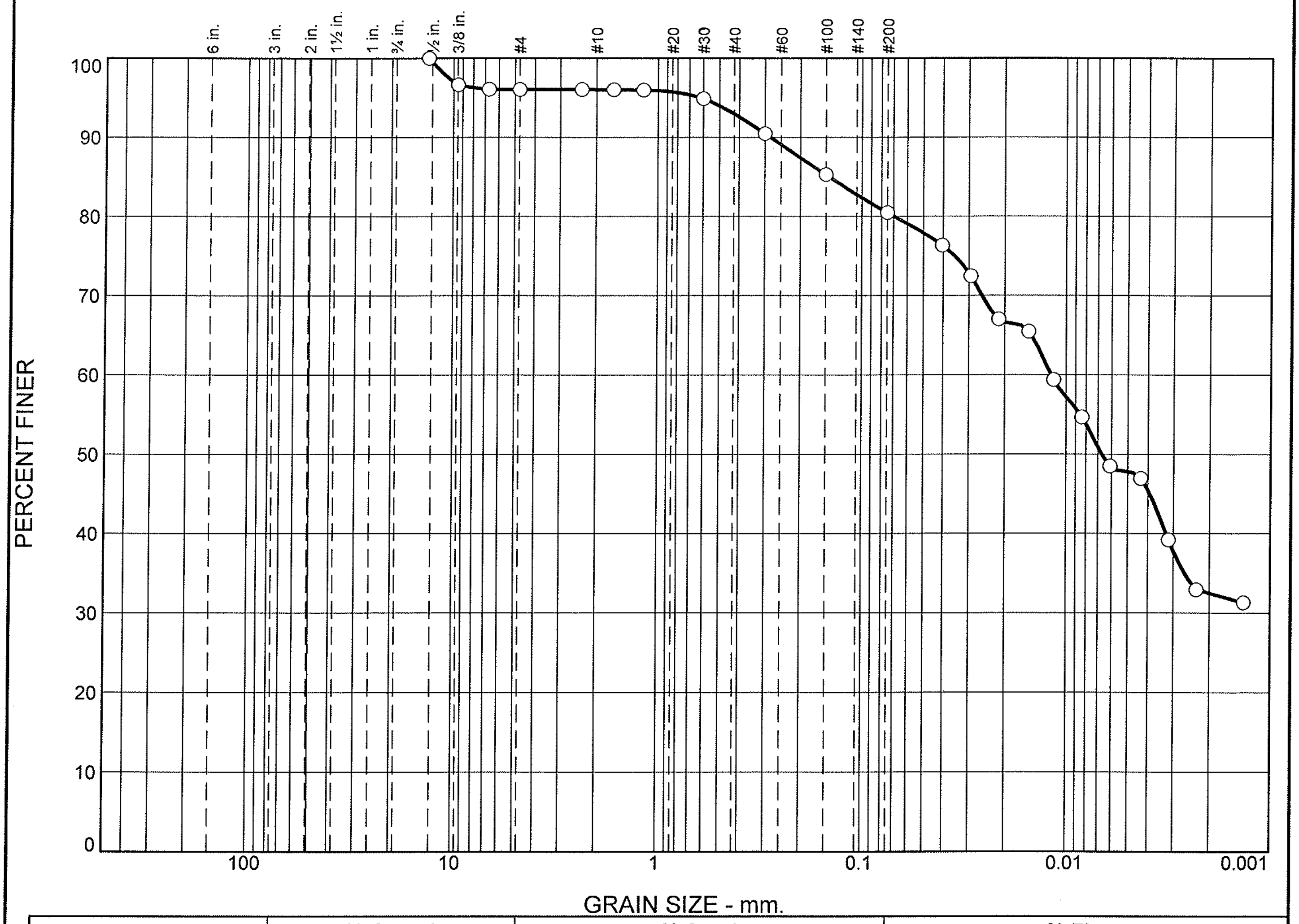
Checked by: L.G.

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	4.0	0.0	3.0	12.5	48.0	32.5

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.1447	0.0119	0.0067					

Material Description	USCS	AASHTO
○ Clayey silt, some sand, trace gravel		

Project No. 37105 **Client:** OHE Consultants
Project: Proposed Development, 100 Emby Drive, Mississauga, Ontario

○ **Source:** BH202 SS4 **Depth:** 7.5' to 9' **Sample No.:** R3802

Remarks:
○ Date of Sampling:
March 1, 2017

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Figure 6

Particle Size Distribution Report

	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	5.8	4.5	5.4	23.8	42.6	17.9

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.4511	0.0739	0.0586	0.0115				

Material Description	USCS	AASHTO
○ Sandy silt, some clay, trace gravel		

Project No. 37105 **Client:** OHE Consultants
Project: Proposed Development, 100 Emby Drive, Mississauga, Ontario

○ **Source:** BH203 SS7 **Depth:** 20' to 21.5' **Sample No.:** R3803

Remarks:
○ Date of Sampling:
March 1, 2017

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Figure 7

APPENDIX A

PHOTOGRAPHS OF EXISTING SLOPE
PROPOSED DEVELOPMENT
51 TANNERY STREET
MISSISSAUGA, ONTARIO

Photograph 1: View of slope

Photograph 2: View of well preserved slope

Photograph 3: View of well vegetated slope

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EXPLANATION OF THE FORM BORING LOG

PENETRATION RESISTANCE

Standard Penetration Resistance 'N'-The number of blows required to advance a standard split spoon sampler 0.3 m into the subsoil. Driven by means of a 63.5 kg hammer falling freely a distance of 0.76 m.

Dynamic Penetration Resistance: - The number of blows required to advance a 51 mm, 60 degree cone, fitted to the end of drill rods, 0.3m , into subsoil. The driving energy being 475 J per blow.

DESCRIPTION OF SOIL

The description of the soil is based on visual examination of the samples and laboratory tests. Each stratum is described according to the following classification and terminology:

Classification*	Particle Size	Particle Size or Sieve No. (U.S. Standard)
Clay	less than 0.002 mm	less than 0.002 mm
Silt	from 0.002 to 0.075 mm	from 0.002 mm to #200 sieve
Sand	from 0.075 to 4.75 mm	from #200 sieve to #4 sieve
Gravel	from 4.75 to 75 mm	from #4 sieve to 3 in.
Cobbles	from 75 to 200 mm	from 3 in. to 8 in.
Boulders	larger than 200 mm	over 8 in.

Terminology	Proportion
Trace, or occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

* Unified Soil Classification System (ASTM D2487-75).

The relative density of cohesionless soils and the consistency of cohesive soils are defined by the following:

Relative Density	Penetration Resistance "N" Blows 0.3 m or Blows foot	Consistency	Underdrained Shear Strength** kPa	psf
Very loose	0 to 4	Very soft	0 to 12	0 to 250
Loose	4 to 10	Soft	12 to 25	250 to 500
Compact	10 to 30	Firm	25 to 50	500 to 1000
Dense	30 to 50	Stiff	50 to 100	1000 to 2000
Very dense	over 50	Very Stiff	100 to 200	2000 to 4000
		Hard	over 200	over 4000

** The compressive strength obtained from the quick (Q) triaxial test is equal to twice the shear strength of the clay.